HARDWARE REFERENCE MANUAL

PMAC2 PCI Lite

Preliminary Documentation

PMAC 2 PCI Lite Bus Expansion Card

4XX-603658-xHxx

November 5, 2003

DELTA TAU
Data Systems, Inc.
NEW IDEAS IN MOTION ...

Single Source Machine Control *Power // Flexibility // Ease of Use*
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INTRODUCTION

Overview

The PMAC2 PCI Lite is a member of the PMAC2 family of boards optimized for interface to three or four sinewave or direct PWM servo drives and to pulse-and-direction stepper drives. It has four channels of servo interface circuitry, but its software is capable of eight axes of control. It is software compatible with the PMAC2-PC and the PMAC2 Mini.

The PMAC2 PCI Lite is a full-sized PCI-bus expansion card. While the PMAC2 PCI Lite is capable of PCI bus communications, with or without the optional on-board dual-ported RAM, it does not need to be inserted into a PCI expansion slot. Communications can be done through the standard on-board RS-232 serial port; standalone operation is possible.

Board Configuration

Base Version

- The base version of the PMAC2 PCI Lite provides a 1-1/2-slot board with:
- 40 MHz DSP563xx CPU
- 128k x 24 zero-wait-state SRAM active memory
- 512k x 8 flash memory for user backup and firmware
- Latest released firmware version (requires V1.17 or newer firmware)
- RS-232/422 serial interface, 33 MHz PCI (PC) bus interface
- Four channels axis interface circuitry, each including:
  - Three output command signal sets, configurable as either:
    - Two serial data streams to external DACs, 1 pulse-and-direction
    - Three PWM top-and-bottom pairs
  - 3-channel differential/single-ended encoder input
  - Nine input flags, two output flags
  - Interface to two external serial ADCs, 8 to 18-bits
- Two channels supplemental interface circuitry, each including:
  - 2-channel differential/single-ended encoder input
  - One output command signal set, configurable as pulse-&-direction or PWM top-and-bottom pair
- Display, muxed I/O, direct I/O interface ports
- Buffered expansion port.
- Clock crystal with ± 100 ppm accuracy.
- PID/notch/feedforward servo algorithms
- 1-year warranty from date of shipment
- One Manuals CD-ROM per set of one to four PMACs in shipment
  (Cables, mounting plates, mating connectors not included)

Option 2: Dual-Ported RAM

Dual-ported RAM provides a high-speed communications path for bus communications with the host computer through a bank of shared memory. DPRAM is advised if more than 100 data items per second are to be passed between the controller and the host computer in either direction.

Option 2 provides an on-board 8k x 16 bank of dual-ported RAM for PCI or USB. The key component on the board is U1.

Option 3: USB1.1 Communications Port

If using the PMAC-PCI Lite in a standalone application, use this port because it faster than the standard RS232/422 communications. Use of this port disables the PCI port.

Option 5: CPU and Memory Configurations

If the 40 MHz CPU (80 MHz DSP 56002 equivalent) that comes standard does not have sufficient computational power, faster versions are available as options. These options provide a faster CPU IC in U127, and unlike past CPU upgrades, will not require any additional memory chips.

- Option 5CF provides an 80 MHz CPU (160 MHz DSP 56002 equivalent) with zero-wait-state SRAM active memory. Requires V1.17 or newer firmware.
- Option 5EF provides a 160 MHz CPU (320 MHz DSP 56002 equivalent) with zero-wait-state SRAM active memory. Requires V1.17 or newer firmware.

Option 6: Extended Servo Algorithm

The standard PID servo algorithm with feedforward and notch filter is suitable for most applications. Systems with difficult dynamics, especially with significant flexibility, may require a more powerful servo algorithm, such as the Extended Servo Algorithm (ESA).

- Option 6 provides an Extended (Pole-Placement) Servo Algorithm firmware instead of the regular servo algorithm firmware. This is required only in difficult-to-control systems (resonances, backlash, friction, disturbances, changing dynamics). This option requires a one-time purchase of the Acc-25 program, which is necessary for tuning the Option-6 firmware.

Option 6L: Multi-block Lookahead Firmware

Option 6L provides a special lookahead firmware for sophisticated acceleration and cornering profiles execution. With the lookahead firmware, PMAC controls the speed along the path automatically (without changing the path) to ensure that axis limits are not violated.

Option 7: Plate Mounting

If the PMAC2 PCI Lite is used as a PCI bus expansion board, the standard hardware is used for proper mounting of the board in the bus. However, if it is not installed in a PCI expansion slot, other provisions must be made for mounting.

Option 7 provides a mounting plate connected to the PMAC2 PCI Lite with standoffs. It is used to install the PMAC2 PCI Lite in standalone applications.

Option 8A: High-Accuracy Clock Crystal

The PMAC2 PCI Lite has a clock crystal (component Y1) of nominal frequency 19.6608 MHz (~20 MHz). The standard crystal's accuracy specification is +/-100 ppm. Long-term velocity accuracy is limited by the accuracy of the crystal, unless an external time base is used.

Option 8A provides a nominal 19.6608 MHz crystal with a +/-15 ppm accuracy specification.

Option 10: Firmware Version Specification

Normally the PMAC2 PCI Lite is provided with the newest released firmware version. A label on the U61 flash memory IC on the CPU board shows the firmware version loaded at the factory.

Option 10 provides for a user-specified firmware version.

Option 12: Analog-to-Digital Converters

With Option 12, eight or 16 channels of on-board multiplexed analog-to-digital converters can be installed. One or two of these converters are read every phase interrupt. The analog inputs are not optically isolated, and each can have a 0 – 5V input range, or a +/-2.5V input range, individually selectable.

Option 12 provides an 8-channel 12-bit A/D converter. The key components on the board are U28 and connector J1.

Option 12A provides an additional 8-channel 12-bit A/D converter. The key component on the board is U29.

Option 16: Battery-Backed Parameter Memory

The contents of the standard memory are not retained through a power-down or reset unless they have been saved to flash memory first. Option 16 provides supplemental battery-backed RAM for real-time parameter storage that is ideal for holding machine state parameters in case of an unexpected power-down.

Option 16 provides a 16k x 24 bank of battery-backed parameter RAM in components U84, U85, U86, with the battery in BT1.

HARDWARE SETUP

Watchdog Timer Jumper

Jumper E19 must be OFF for the watchdog timer to operate. This is an important safety feature, so it is vital that this jumper be OFF in normal operation. E19 should be put ON only to debug problems with the watchdog timer circuit.

CPU Frequency Control Jumpers

If variable I46 is set to the default value of zero, jumpers E2 and E4 on the base PMAC2 PCI Lite board control the frequency at which the CPU will operate (or attempt to operate). Generally, this will be the highest frequency at which the CPU is rated to operate.

- If jumpers E2 and E4 are both OFF, the CPU will operate at a 40MHz frequency.
- If E2 is ON and E4 is OFF, the CPU will operate at a 60MHz frequency.
- If E2 is OFF and E4 is ON, the CPU will operate at an 80MHz frequency.
- If I46 is set to a value greater than zero, E2 and E4 are not used. The CPU frequency is set to 10MHz (I46+1)

Re-Initialization Jumper

If E3 is off during power-up/reset, the controller will load its last saved set-up parameters from flash memory into active memory. This is the setting for normal operation.

If E3 is on during power-up/reset, the controller will load its factory-default set-up parameters from firmware into active memory. Generally, this is done only if communications cannot be established with the card when it comes up in normal operational mode.

Power-Up State Jumpers

Jumper E20 must be OFF, jumper E21 must be ON, and jumper E22 must be ON, in order for the CPU to copy the firmware from flash memory into active RAM on power-up/reset. This is necessary for normal operation of the card. (Other settings are for factory use only.)

Firmware Load Jumper

If jumper E23 is ON during power-up/reset, the board comes up in bootstrap mode which permits the loading of new firmware into the flash-memory IC on the board. When the PMAC Executive program tries to establish communications with a board in this mode, it will detect automatically that the board is in bootstrap mode and ask what file to download as the new firmware.

Jumper E23 must be OFF during power-up/reset for the board to come up in normal operational mode.

Flash Memory Bank Select Jumpers

The flash-memory IC in location U10 on the Flex CPU board has the capacity for eight separate banks of firmware, only one of which can be used at any given time. The eight combinations of settings for jumpers E10A, E10B, and E10C select which bank of the flash memory is used. In the factory production process, firmware is loaded only into Bank 0 which is selected by having all of these jumpers OFF.

Encoder Sample Clock Source Jumpers

Jumper E13 controls the source of the SCLK encoder-sampling clock for each servo IC. The default setting, No Jumper Installed, means that the SCLK signal comes from the servo IC and is output on the JMACH connectors. This setting is suitable for all but a few special applications.

Serial Port Selection Jumper

Jumpers E17 and E18 control which serial-port connector is used. If E17 and E18 connect their pins 1 and 2, the 10-pin RS-232 port connector J5 is used. If E17 and E18 connect their pins 2 and 3, the 26-pin RS-422 port connector J5A is used. The RS-422 port must be used if several cards are to be daisy-chained together on a single multi-drop cable.

Output Disable State Jumpers

Jumpers E111 through E114 control the hardware state of the digital command output signals for each channel when the amplifier enable signal for that channel is in the disable state (false). Jumper E11*n* (*n* = 1 to 4) controls the output signals for channel *n* on the board.

If E11*n* is off (default), the command output signals for channel *n* are still active when the amplifier enable signal is in the disable state. The Turbo PMAC software should be commanding a net zero command to be output on these signals, and the amplifier-enable signal should be used by the amplifier so that no command output will cause action if it is receiving a disable signal. The Off setting should be used when DAC output format is selected for the channel.

If E11*n* is on, the command output signals for channel *n* are tri-stated when the amplifier-enable signal is in the disable state. This setting is used only with direct-PWM power-block amplifiers that do not use amplifier enable to gate the PWM signals, and in which the zero-command format of 50% top on-time, and 50% bottom on-time cannot be tolerated in the disable state.

Amplifier Enable / EQU Jumper

WARNING

The jumper setting must match the type of driver IC, or damage to the IC will result.

Jumpers E11 and E12 control the polarity of the AENA and EQU lines. Their default setting is 1 to 2 which applies GND to pin 10 of U93 AENA/EQUn driver IC. This is used for 74ACT563, 74ACT573, and ULN2803 model sinking chips.

To source the AENA and EQU lines, apply +V to pin 10 of U93, jump pin 2 to 3. This is used for UDN2891 model sourcing chip.

Note:

If using ULN2803 or UDN2981 model chips, be sure to plug pin 1 of chip into socket starting at pin 2.

Resistor Pack Configuration

Termination Resistors

The PMAC2 PCI Lite provides sockets for termination resistors on differential input pairs coming into the board. As shipped, there are no resistor packs in these sockets. If these signals are brought long distances into the PMAC2 PCI Lite board and ringing at signal transitions is a problem, SIP resistor packs may be mounted in these sockets to reduce or eliminate the ringing.

All termination resistor packs have independent resistors (no common connection) with each resistor using two adjacent pins. The following table shows which packs are used to terminate each input device:

Input	Pack	Pack Size	Input	Pack	Pack Size
Encoder 1	RP60	6-pin	ADC 1 & 2	RP60	8-pin
Encoder 2	RP62	6-pin	ADC 3 & 4	RP61	8-pin
Encoder 3	RP66	6-pin	ADC 5 & 6	RP121	8-pin
Encoder 4	RP68	6-pin	ADC 7 & 8	RP122	8-pin
Encoder 5	RP107	6-pin	Fault 1 & 2	RP63	6-pin
Encoder 6	RP111	6-pin	Fault 3 & 4	RP64	6-pin
Encoder 7	RP108	6-pin	Fault 5 & 6	RP124	6-pin
Encoder 8	RP112	6-pin	Fault 7 & 8	RP125	6-pin
SCLK12&34	RP52	6-pin	SCLK56&78	RP113	6-pin

Pull-Up/Pull-Down Resistors

The differential input signal pairs to the PMAC2 PCI Lite have user-configurable pull-up/pull-down resistor networks to permit the acceptance of either single-ended or differential signals in one setting, or the detection of lost differential signals in another setting.

The + inputs of each differential pair each have a hard-wired 1 kohm pull-up resistor to +5V. This cannot be changed.

The - inputs of each differential pair each have a hard-wired 2.2 kohm resistor to +5V; each has another 2.2 kohm resistor as part of a socketed resistor pack that can be configured as a pull-up resistor to +5V, or a pull-down resistor to GND.

If this socketed resistor is configured as a pull-down resistor (the default configuration), the combination of pull-up and pull-down resistors on this line acts as a voltage divider, holding the line at +2.5V in the absence of an external signal. This configuration is required for single-ended inputs using the '+' lines alone; it is used for unconnected inputs to prevent the pick-up of spurious noise. It is permissible for differential line-driver inputs.

If this socketed resistor is configured as a pull-up resistor (by reversing the SIP pack in the socket), the two parallel 2.2 kohm resistors act as a single 1.1 kohm pull-up resistor, holding the line at +5V in the absence of an external signal. This configuration is required if encoder-loss detection is desired; or if complementary open-collector drivers are used. It is permissible for differential line-driver inputs even without encoder loss detection.

If Pin 1 of the resistor pack (marked by a dot on the pack) matches Pin 1 of the socket (marked by a wide white line on the front side of the board and a square solder pin on the back side of the board), then the pack is configured as a bank of pull-down resistors. If the pack is reversed in the socket, it is configured as a bank of pull-up resistors.

The following table lists the pull-up/pull-down resistor pack for each input device:

Device	Resistor Pack	Device	Resistor Pack
Encoder 1	RP43	ADC/Fault1&2	RP58
Encoder 2	RP48	ADC/Fault3&4	RP59
Encoder 3	RP44	ADC/Fault5&6	RP119
Encoder 4	RP49	ADC/Fault7&8	RP120
Encoder 5	RP104	SCLK12&34	RP62
Encoder 6	RP109	SCLK56&78	RP123
Encoder 7	RP105		
Encoder 8	RP110		

Connections

Mounting

The PMAC2 PCI Lite can be mounted in one of two ways: in the PCI bus, or using standoffs.

1. PCI bus: To mount in the PCI bus, simply insert the P1 card-edge connector into the PCI socket. If there is a standard PC-style housing, a bracket at the end of the PMAC2 PCI Lite board can be used to screw into the housing to hold the board down firmly.
2. Standoffs: At each of the Four Corners of the PMAC2 PCI Lite board, there are mounting holes that can be used to mount the board on standoffs.

Power Supply Connection

The standard PMAC2 PCI Lite requires only 5V power: 3A in a 4-channel configuration, 4A in an 8-channel configuration (with Option 1). If the Option 12 A/D converters are installed, a –12V supply is also required. In this case, a +12V supply also can be passed through the card and out to the analog devices feeding the A/D converters.

The power can be provided in several ways:

- Bus connector: If the PMAC2 PCI Lite is mounted in an electrically active PCI bus slot, it draws its 5V and +/-12V power from the bus automatically.
- Terminal block: The TB1 2/4-point terminal block can be used to bring in 5V power, especially in standalone applications. Point 1 is GND; Point 2 is +5V. Points 3 and 4 are needed only if the Option-12 A/D converters are ordered.
- JMACH connectors: Up to 2A may be brought in through each 100-pin JMACH connector from an Acc-8 board or its equivalent, provided the cable is 500mm (20 inches) or less in length.

Machine Port Connections

The PMAC2 PCI Lite has a 100-pin high-density header for each pair of servo interface channels. Through this connector, pass all of the digital signals to and from the amplifier, encoder, and flags for the two channels. Typically, this header is connected with a matching Delta Tau Acc-8 family 2-channel breakout board or equivalent through a provided 100-pin flat cable.

The machine port connectors are:

- J9 (JMACH1) Board Channels 1 & 2
- J10 (JMACH2) Board Channels 3 & 4

Display Port

The J6 (JDISP) display port provides a 14-pin IDC header for connection to the Acc-12 family of displays. Flat cables are provided with each of these displays for direct connection between the display and this port.

Multiplexer Port

The J2 (JTHW) multiplexer port provides eight TTL-compatible 5V CMOS inputs and eight TTL-compatible 5V CMOS outputs on a 26-pin IDC header. These can be used directly as general-purpose digital I/O, or with PMAC2's special M-variable support (TWB, TWD, TWR, and TWS formats). In addition, they can be used to support hundreds, or even thousands of multiplexed I/O points on accessory boards.

Delta Tau provides the following accessory boards that can be connected to the multiplexer port. Each comes with a flat cable for direct connection to the port.

- Acc-8D Option 7 Resolver-to-Digital Converter Board
- Acc-18 Thumbwheel Board
- Acc-34 family of Digital I/O Boards
- Acc-35A and B Extender Boards

I/O Port

The J3 (JIO) I/O port provides 32 TTL-compatible 5V CMOS I/O points on a 40-pin IDC header. Direction is selectable by byte. These are used as general-purpose digital I/O points. Acc-21A provides a convenient connections adapter from this port to OPTO-22 style boards.

Serial Ports

The PMAC2 PCI Lite has two serial-port connectors. Only one of these can be used in an application.

- J5 is a 10-pin IDC header for RS-232 communications. It can be connected to a standard DB9 RS-232 connector on a host computer or terminal via a flat cable such as the Acc-3L. A commercially available DB9-to-DB25 adapter can be added to this flat cable if the host computer or terminal has a DB25 serial connector. Jumpers E17 and E18 on the PMAC2 PCI Lite must connect pins 1 and 2 to use this port.
- J5A is 26-pin IDC header for RS-422 communications. It can be connected to a standard DB25 RS-422 connector on a host computer or terminal via a flat cable such as the Acc-3D. Jumpers E17 and E18 on the PMAC2 PCI Lite must connect pins 2 and 3 to use this port.

A/D-Converter Port

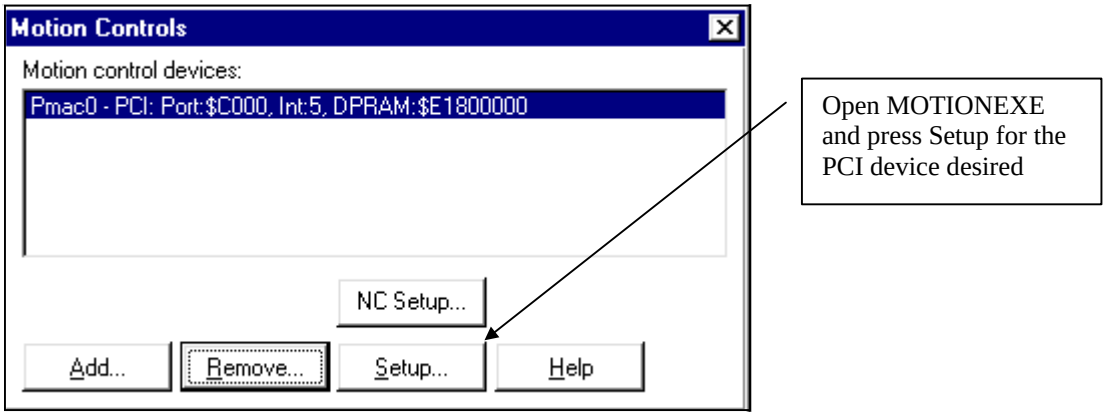
If the Option 12 A/D converters are ordered, the J1 (JANA) analog-input port is provided on the PMAC2 on a 20-pin IDC header. Option 12 provides eight analog inputs at 0 – 5V, or +/-2.5V levels. Option 12A provides eight additional analog inputs at these levels. The +12V and –12V supplies can either be brought in on this connector, or brought out on it for the external analog circuitry, if they have been brought in through TB1 or P1.

Handwheel Port

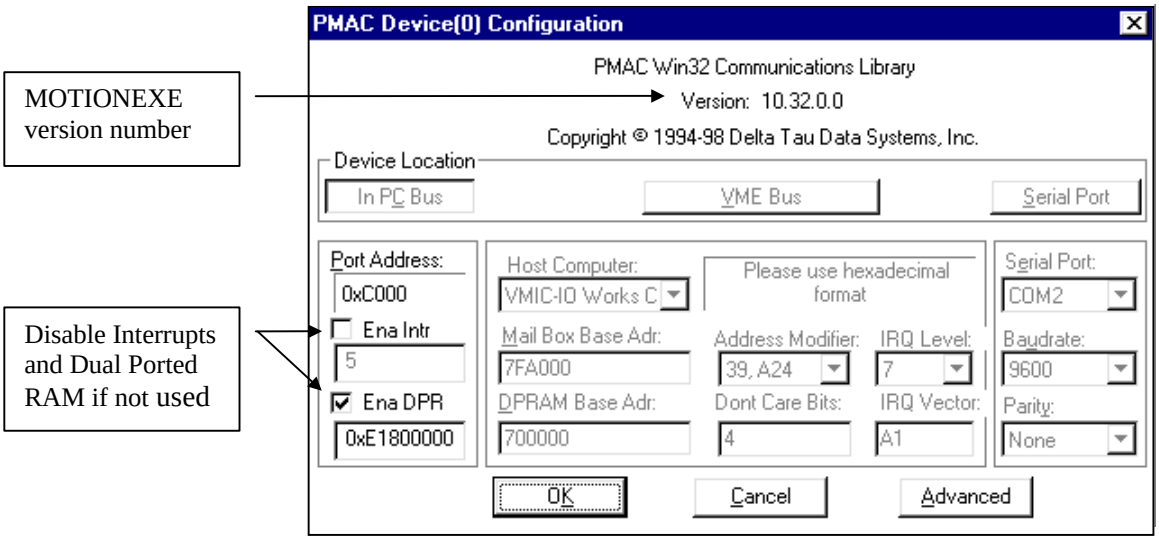
The J7 (JHW) handwheel port provides two limited supplemental channels, each with a 2-channel encoder input, and a pulse-and-direction or PWM top-and-bottom pair output. All inputs and outputs are digital 5V differential line-driver pairs.

COMMUNICATIONS SETUP

Delta Tau provides communication tools that take advantage of the PCI bus Plug and Play feature of 32-bits Windows® based computers. Starting with MOTIONEXE.EXE version 10.32.00, which is included in PEWIN32 version 2.32 and newer, a PMAC2 PCI Lite board plugged in a PCI bus slot will be recognized by the operating system when the computer is booted up. The available PCI address, Dual-Ported RAM address and Interrupt lines are set automatically by the operating system and can be checked (but not modified) in the MOTIONEXE.EXE application.



The PMAC2 PCI Lite board may have the optional on-board Dual-Ported RAM circuitry which is ordered through Option-2. If the dual-ported RAM circuitry is not on-board, manually disable its automatically assigned use through the setup page of MOTIONEXE:



The MOTIONEXE application will look first for PMAC PCI boards on the PCI bus and will assign device numbers from Device0 to each PMAC PCI sequentially until all the PMAC PCI boards found have a device number assigned. Then, manually add other devices for either ISA bus or Serial port communications.

After each PMAC has a device number assigned to it, communications through the PCI bus are identical to the ISA bus. Any application written for the ISA bus using the Delta Tau provided 32-bits communication libraries provided will not require any further change and the process is transparent.

Note:

For example, if a Device0 for serial RS-232 communications was defined before a PMAC PCI board was installed in the computer, its setup information will be overwritten by the MOTIONEXE application when the PMAC2 PCI Lite board is found. Therefore, it is important to take note of the all the devices and their parameters defined in MOTIONEXE before installing a new PMAC board in the computer.

FLEX CPU BOARD JUMPER DESCRIPTIONS

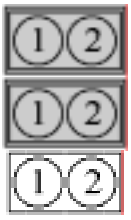
E1: Watchdog Disable Jumper

E Point and Physical Layout	Description	Default
E1 	Jump pin 1 to 2 to disable Watchdog timer. (For test purposes only.) Remove jumper to enable Watchdog timer.	No jumper installed

E2: Dual-Ported Ram Port Select

E Point and Physical Layout	Description	Default
E2 	Jump pin 1 to 2 to access DPRAM from baseboard. Jump pin 2 to 3 to access DPRAM through JEXP expansion port.	Pins 1 and 2 jumpered

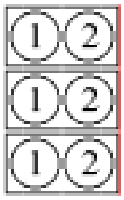
E4 – E6: Power-Up/Reset Load Source

E Point and Physical Layout	Description	Default
E6  **E4**	Remove jumper E4; Jump E5 pin 1 to 2; Jump E6 pin 2 to 3; to read flash IC on power-up/reset. Other combinations are for factory use only; the board will not operate in any other configuration.	No E4 jumper installed; E5 and E6 jump pin 1 to 2

E7: Firmware Reload Enable

E Point and Physical Layout	Description	Default
E7 	Jump pin 1 to 2 to reload firmware through serial or bus port. Remove jumper for normal operation.	No jumper installed

E10A, B, C: Flash Memory Bank Select

E Point and Physical Layout	Description	Default
E10A  **E10C**	Remove all three jumpers to select flash memory bank with factory-installed firmware. Use other configuration to select one of the seven other flash memory banks.	No jumpers installed

JUMPER DESCRIPTIONS

E1: Servo and Phase Clock Direction Control

E Point and Physical Layout	Location	Description	Default
E1	C2	Remove jumper for PMAC2 PCI Lite to use its internally generated servo and phase clock signals and to output these signals on the J5A serial port connector. Jump pins 1 and 2 for PMAC2 PCI Lite to expect to receive its servo and phase clock signals on the J5A serial port connector.	No jumper installed
Note: If the E1 jumper is ON and the servo and phase clocks are not brought in on the J5A serial port, the watchdog timer will trip immediately.			

E2: CPU Frequency Select

E Point and Physical Layout	Location	Description	Default
E2	C2	Remove jumper for 40MHz operation (E4 OFF also) or for 80MHz operation (E4 ON) with I46 = 0. Jump pin 1 to 2 for 60MHz operation (E4 OFF) with I46 = 0. Not used if I46 > 0.	No jumper installed Jumper installed

E3: Normal/Re-Initializing Power-Up/Reset

E Point and Physical Layout	Location	Description	Default
E3	C2	Jump pin 1 to 2 to re-initialize on power-up/reset, loading factory default settings. Remove jumper for normal power-up/reset, loading user-saved settings.	No jumper installed

E4: CPU Frequency Select

E Point and Physical Layout	Location	Description	Default
E4	C2	Remove jumper for 40MHz operation (E2 OFF also) or for 60MHz operation (E4 ON) with I46 = 0. Jump pin 1 to 2 for 80MHz operation (E2 OFF) with I46 = 0. Not used if I46 > 0	No jumper installed (standard or Opt 5B) Jumper installed (Opt 5C)

E5 – E6: (Reserved for Future Use)

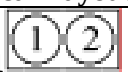
E13 - E14: Encoder Sample Clock Direction Control

E Point and Physical Layout	Location	Description	Default
E13	D1	Remove jumper to output SCLK generated in first ASIC on SCLK_12 and SCLK_34, or to control direction by software. Jump pins 1 to 2 to input SCLK signal for first ASIC on SCLK_34 and output this signal on SCLK_12. Jump pins 2 to 3 to input SCLK signal for first ASIC on SCLK_12 and output this signal on SCLK_34.	No jumper installed
E14	D2	Remove jumper to output SCLK generated in second ASIC on SCLK_56 and SCLK_78, or to control direction by software. Jump pins 1 to 2 to input SCLK signal for second ASIC on SCLK_78 and output this signal on SCLK_56. Jump pins 2 to 3 to input SCLK signal for second ASIC on SCLK_56 and output this signal on SCLK_78.	No jumper installed
Note: E14 is installed only if Option 1 has been ordered.			

E17 - E18: Serial Port Type Selection

E Point and Physical layout	Location	Description	Default
E17	C1	Connect pins 1 and 2 to use the RS-232 port on the J5 connector. Connect pins 2 and 3 to use the RS-422 port on the J5A connector.	Jumper installed in 1-2 position
E18	C1	Connect pins 1 and 2 to use the RS-232 port on the J5 connector. Connect pins 2 and 3 to use the RS-422 port on the J5A connector.	Jumper installed in 1-2 position
Serial Port Choice: Because both RS-232 and RS-422 ports are always provided, jumpers must be set correctly to use the port of choice. Jumpers E17 and E18 must connect pins 1 and 2 to use the RS-232 port on the J5 connector; to use the RS-422 port on the J5A connector, they must connect pins 2 and 3.			

E111-118: Command Output Disable State

E Point and Physical Layout	Location	Description	Default
E111  **E112** **E113** **E114** **E115** **E116** **E117** **E118**	C1	Jump pin 1 to 2 of E11*n* for digital servo command output signals of Channel *n* to tri-state when amplifier-enable signal for Channel *n* is in disable state. Remove jumper for digital servo command output signals of Channel *n* to remain active (but typically with zero command value) when amplifier-enable signal for Channel *n* is in disable state.	No jumper installed

MATING CONNECTORS

CPU Board Connectors

J2 (JEXP)/Expansion

- Two 50-pin female flat cable connector Delta Tau P/N 014-R00F50-0K0 - T&B Ansley P/N 609-5041
- 171-50 T&B Ansley standard flat cable stranded 50-wire
- Phoenix varioface module type FLKM 50 (male pins) P/N 22 81 08 9

Baseboard Connectors

J1 (JANA)/Analog (Option 12)

- Two 14-pin female flat cable connector Delta Tau P/N 014-R00F14-0K0 - T&B Ansley P/N 609-1441
- 171-14 T&B Ansley standard flat cable stranded 14-wire
- Phoenix varioface modules type FLKM14 (male pins) P/N 22 81 02 1

J2 (JTHW)/Multiplexer Port

- Two 26-pin female flat cable connector Delta Tau P/N 014-R00F26-0K0 - T&B Ansley P/N 609-2641
- 171-26 T&B Ansley standard flat cable stranded 26-wire
- Phoenix varioface module type FLKM 26 (male pins) P/N 22 81 05 0

J3 (JIO)/Digital I/O

- Two 40-pin female flat cable connector Delta Tau P/N 014-R00F40-0K0 - T&B Ansley P/N 609-4041
- 171-40 T&B Ansley standard flat cable stranded 40-wire
- Phoenix varioface module type FLKM 40 (male pins)

J5 (JRS232)/RS-232 Serial Communications

- Two 10-pin female flat cable connector Delta Tau P/N 014-ROOF10-0K0 - T&B Ansley P/N 609-1041
- 171-10 T&B Ansley standard flat cable stranded 10-wire
- Phoenix varioface module type FLKM 10 (male pins) P/N 22 81 01 8

J5A (JRS422)/RS-422 Serial Communications

- Two 26-pin female flat cable connector Delta Tau P/N 014-R00F26-0K0 - T&B Ansley P/N 609-2641
- 171-26 T&B Ansley standard flat cable stranded 26-wire
- Phoenix varioface module type FLKM 26 (male pins) P/N 22 81 05 0

J6 (JDISP)/Display

- Two 14-pin female flat cable connector Delta Tau P/N 014-R00F14-0K0 - T&B Ansley P/N 609-1441
- 171-14 T&B Ansley standard flat cable stranded 14-wire
- Phoenix varioface modules type FLKM14 (male pins) P/N 22 81 02 1

J7 (JHW)/Auxiliary Channel

- Two 20-pin female flat cable connector Delta Tau P/N 014-R00F20-0K0 - T&B Ansley P/N 609-2041
- 171-20 T&B Ansley standard flat cable stranded 20-wire
- Phoenix varioface modules type FLKM20 (male pins)

J8 (JEQU)/Position Compare

- Two 10-pin female flat cable connector Delta Tau P/N 014-ROOF10-0K0 - T&B Ansley P/N 609-1041
- 171-10 T&B Ansley standard flat cable stranded 10-wire
- Phoenix varioface module type FLKM 10 (male pins) P/N 22 81 01 8

J9 (JMACH1)/Machine Port 1

- Two 100-pin high-density box header with center key, 0.050” pitch - AMP P/N 1-04068-7, Delta Tau P/N 014-00010-FPB
- High-density flat cable stranded 100-wire

J10 (JMACH2)/Machine Port 2

- Two 100-pin high-density box header with center key, 0.050” pitch - AMP P/N 1-04068-7, Delta Tau P/N 014-00010-FPB
- High-density flat cable stranded 100-wire

BASE BOARD CONNECTOR PINOUTS

J1 (JANA) Analog Input Port Connector

This connector is present only if Option 12 is ordered.

Pin #	Symbol	Function	Description	Notes
1	ANAI00	Input	Analog input 0	0-5V or +/-2.5V range
2	ANAI01	Input	Analog input 1	0-5V or +/-2.5V range
3	ANAI02	Input	Analog input 2	0-5V or +/-2.5V range
4	ANAI03	Input	Analog input 3	0-5V or +/-2.5V range
5	ANAI04	Input	Analog input 4	0-5V or +/-2.5V range
6	ANAI05	Input	Analog input 5	0-5V or +/-2.5V range
7	ANAI06	Input	Analog input 6	0-5V or +/-2.5V range
8	ANAI07	Input	Analog input 7	0-5V or +/-2.5V range
9	ANAI08	Input	Analog input 8	0-5V or +/-2.5V range *
10	ANAI09	Input	Analog input 9	0-5V or +/-2.5V range *
11	ANAI10	Input	Analog input 10	0-5V or +/-2.5V range *
12	ANAI11	Input	Analog input 11	0-5V or +/-2.5V range *
13	ANAI12	Input	Analog input 12	0-5V or +/-2.5V range *
14	ANAI13	Input	Analog input 13	0-5V or +/-2.5V range *
15	ANAI14	Input	Analog input 14	0-5V or +/-2.5V range *
16	ANAI15	Input	Analog input 15	0-5V or +/-2.5V range *
17	GND	Common	PMAC common	Not isolated from digital
18	+12V	Output	Positive supply voltage	To power external circuitry
19	GND	Common	PMAC common	Not isolated from digital
20	-12V	Output	Negative supply voltage	To power external circuitry

*This signal is present only if Option-12A is ordered.

The JANA connector provides the inputs for the 8 or 16 optional analog inputs on the PMAC2.

J2 (JTHW) Multiplexer Port Connector

Pin #	Symbol	Function	Description	Notes
1	GND	Common	PMAC common	
2	GND	Common	PMAC common	
3	DAT0	Input	Data-0 input	Data input from MUX port accessories
4	SEL0	Output	Select-0 output	Address/data output for MUX port accessories
5	DAT1	Input	Data-1 input	Data input from MUX port accessories
6	SEL1	Output	Select-1 output	Address/data output for MUX port accessories
7	DAT2	Input	Data-2 input	Data input from MUX port accessories
8	SEL2	Output	Select-2 output	Address/data output for MUX port accessories
9	DAT3	Input	Data-3 input	Data input from MUX port accessories
10	SEL3	Output	Select-3 output	Address/data output for MUX port accessories
11	DAT4	Input	Data-4 input	Data input from MUX port accessories
12	SEL4	Output	Select-4 output	Address/data output for MUX port accessories
13	DAT5	Input	Data-5 input	Data input from MUX port accessories
14	SEL5	Output	Select-5 output	Address/data output for MUX port accessories
15	DAT6	Input	Data-6 input	Data input from MUX port accessories
16	SEL6	Output	Select-6 output	Address/data output for MUX port accessories
17	DAT7	Input	Data-7 input	Data input from MUX port accessories
18	SEL7	Output	Select-7 output	Address/data output for MUX port accessories
19	N.C.	No Connection	No connection	
20	GND	Common	PMAC common	
21	BRLD/	Output	Buffer request	Low is buffer required
22	GND	Common	PMAC common	
23	IPLD/	Output	In position	Low is in position
24	GND	Common	PMAC common	
25	+5V	Output	+5Vdc supply	Power supply out
26	INIT/	Input	PMAC reset	Low is reset

J3 (JI/O) General Input/Output Connector

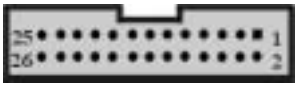
Pin #	Symbol	Function	Description	Notes
1	I/O00	In/Out	Digital I/O 0	Software direction ctrl.
2	I/O01	In/Out	Digital I/O 1	Software direction ctrl.
3	I/O02	In/Out	Digital I/O 2	Software direction ctrl.
4	I/O03	In/Out	Digital I/O 3	Software direction ctrl.
5	I/O04	In/Out	Digital I/O 4	Software direction ctrl.
6	I/O05	In/Out	Digital I/O 5	Software direction ctrl.
7	I/O06	In/Out	Digital I/O 6	Software direction ctrl.
8	I/O07	In/Out	Digital I/O 7	Software direction ctrl.
9	I/O08	In/Out	Digital I/O 8	Software direction ctrl.
10	I/O09	In/Out	Digital I/O 9	Software direction ctrl.
11	I/O10	In/Out	Digital I/O 10	Software direction ctrl.
12	I/O11	In/Out	Digital I/O 11	Software direction ctrl.
13	I/O12	In/Out	Digital I/O 12	Software direction ctrl.
14	I/O13	In/Out	Digital I/O 13	Software direction ctrl.
15	I/O14	In/Out	Digital I/O 14	Software direction ctrl.
16	I/O15	In/Out	Digital I/O 15	Software direction ctrl.
17	I/O16	In/Out	Digital I/O 16	Software direction ctrl.
18	I/O17	In/Out	Digital I/O 17	Software direction ctrl.
19	I/O18	In/Out	Digital I/O 18	Software direction ctrl.
20	I/O19	In/Out	Digital I/O 19	Software direction ctrl.
21	I/O20	In/Out	Digital I/O 20	Software direction ctrl.
22	I/O21	In/Out	Digital I/O 21	Software direction ctrl.
23	I/O22	In/Out	Digital I/O 22	Software direction ctrl.
24	I/O23	In/Out	Digital I/O 23	Software direction ctrl.
25	I/O24	In/Out	Digital I/O 24	Software direction ctrl.
26	I/O25	In/Out	Digital I/O 25	Software direction ctrl.
27	I/O26	In/Out	Digital I/O 26	Software direction ctrl.
28	I/O27	In/Out	Digital I/O 27	Software direction ctrl.
29	I/O28	In/Out	Digital I/O 28	Software direction ctrl.
30	I/O29	In/Out	Digital I/O 29	Software direction ctrl.
31	I/O30	In/Out	Digital I/O 30	Software direction ctrl.
32	I/O31	In/Out	Digital I/O 31	Software direction ctrl.
33	GND	Common	Reference voltage	
34	GND	Common	Reference voltage	
35	PHASE/	Output	Phase clock	For latching data
36	SERVO/	Output	Servo clock	For latching data
37	GND	Common	Reference voltage	
38	GND	Common	Reference voltage	
39	+5V	Output	Supply voltage	To power external circuitry
40	+5V	Output	Supply voltage	To power external circuitry
The JI/O connector provides 32 input/output pins at TTL levels. Direction can be controlled in byte-wide groups.				

J5 (JRS232) Serial Port Connector

Pin #	Symbol	Function	Description	Notes
1	PHASE	Output	Phasing clock	
2	DTR	Bidirect	Data terminal ready	Tied to DSR
DSR	TXD/	Input	Receive data	Host transmit data
4	CTS	Input	Clear to send	Host ready bit
5	RXD/	Output	Send data	Host receives data
6	RTS	Output	Req. to send	PMAC ready bit
7	DSR	Bidirect	Data set ready	Tied to DTR
8	SERVO	Output	Servo clock	
9	GND	Common	PMAC common	
10	+5V	Output	+5Vdc supply	Power supply out
The JRS232 connector provides the PMAC2-PC with the ability to communicate serially with an RS232 port. This connector cannot be used for daisy-chain interconnection of multiple PMACs. The J5A RS-422 port must be used for daisy chaining. E17 and E18 must connect pins 1 and 2 to use the RS-232 port for serial communications.				

J5A (RS422) Serial Port Connector

JRS422 (26-PIN Connector)



Front View

Pin #	Symbol	Function	Description	Notes
1	CHASSI	Common	PMAC common	
2	S+5V	Output	+5Vdc supply	
3	RD-	Input	Receive data	Diff. I/O low true
4	RD+	Input	Receive data	Diff. I/O high true
5	SD-	Output	Send data	Diff. I/O low true
6	SD+	Output	Send data	Diff. I/O high true
7	CS+	Input	Clear to send	Diff I/O high true
8	CS-	Input	Clear to send	Diff. I/O low true
9	RS+	Output	Req. to send	Diff. I/O high true
10	RS-	Output	Req. to send	Diff I/O low true
11	DTR	Bidirect	Data term read	Tied to DSR
12	INIT/	Input	PMAC reset	Low is "reset"
13	GND	Common	PMAC common	
14	DSR	Bidirect	Data set ready	Tied to DTR
15	SDIO-	Bidirect	Special data	Diff. I/O low true
16	SDIO+	Bidirect	Special data	Diff. I/O high true
17	SCIO-	Bidirect	Special ctrl.	Diff I/O low true
18	SCIO+	Bidirect	Special ctrl.	Diff. I/O high true
19	SCK-	Bidirect	Special clock	Diff. I/O low true
20	SCK+	Bidirect	Special clock	Diff. I/O high true
21	SERVO-	Bidirect	Servo clock	Diff. I/O low true
22	SERVO+	Bidirect	Servo clock	Diff. I/O high true
23	PHASE-	Bidirect	Phase clock	Diff. I/O low true
24	PHASE+	Bidirect	Phase clock	Diff. I/O high true
25	GND	Common	PMAC common	
26	+5V	Output	+5Vdc supply	Power supply out
E17 and E18 must connect pins 2 and 3 to use the RS-422 port for serial communications. This connector could be also used to daisychain interconnect multiple PMACs for synchronized operation.				

J6 (JDISP) Display Connector

Pin #	Symbol	Function	Description	Notes
1	VDD	Output	+5V power	Power supply out
2	VSS	Common	PMAC common	
3	RS	Output	Read strobe	TTL signal out
4	VEE	Output	Contrast adjust. VEE	0 to +5 Vdc *
5	E	Output	Display enable	High is enable
6	R/W	Output	Read or write	TTL signal out
7	DB1	Output	Display data1	
8	DB0	Output	Display data0	
9	DB3	Output	Display data3	
10	DB2	Output	Display data2	
11	DB5	Output	Display data5	
12	DB4	Output	Display data4	
13	DB7	Output	Display data7	
14	DB6	Output	Display data6	
The JDISP connector is used to drive the 2-line x 24-character (Acc-12), 2 x 40 (Acc-12A) LCD, or the 2 x 40 vacuum fluorescent (Acc-12C) display unit. The **DISPLAY** command may be used to send messages and values to the display.				

J7 (JHW) Handwheel Encoder Connector

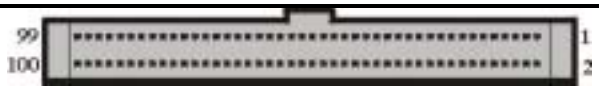
Pin #	Symbol	Function	Description	Notes
1	GND	Common	Reference voltage	
2	+5V	Output	Supply voltage	To power external circuitry
3	HWA1+	Input	HW positive A channel	Also pulse input
4	HWA1-	Input	HW negative A channel	Also pulse input
5	HWB1+	Input	HW positive B channel	Also direction input
6	HWB1-	Input	HW negative B channel	Also direction input
7	HWA2+	Input	HW positive A channel	Also pulse input
8	HWA2-	Input	HW negative A channel	Also pulse input
9	HWB2+	Input	HW positive B channel	Also direction input
10	HWB2-	Input	HW negative B channel	Also direction input
11	PUL1+	Output	PFM positive pulse	Also PWM bottom output
12	PUL1-	Output	PFM negative pulse	Also PWM bottom output
13	DIR1+	Output	PFM positive dir out	Also PWM top output
14	DIR1-	Output	PFM negative dir out	Also PWM top output
15	PUL2+	Output	PFM positive pulse	Also PWM bottom output
16	PUL2-	Output	PFM negative pulse	Also PWM bottom output
17	DIR2+	Output	PFM positive dir. out	Also PWM top output
18	DIR2-	Output	PFM negative dir out	Also PWM top output
19	GND	Common	Reference voltage	
20	+5V	Output	Supply voltage	To power external circuitry
The VHW connector provides for two 2-channel encoder inputs and two sets of pulse outputs.				

J8 (JEQU) Position Compare Output Connector

Pin #	Symbol	Function	Description	Notes
1	EQU1/	Output	Encoder 1 comp-Eq	Programmed polarity
2	EQU2/	Output	Encoder 2 comp-Eq	Programmed polarity
3	EQU3/	Output	Encoder 3 comp-Eq	Programmed polarity
4	EQU4/	Output	Encoder 4 comp-Eq	Programmed polarity
5	EQU5/	Output	Encoder 5 comp-Eq	Programmed polarity
6	EQU6/	Output	Encoder 6 comp-Eq	Programmed polarity
7	EQU7/	Output	Encoder 7 comp-Eq	Programmed polarity
8	EQU8/	Output	Encoder 8 comp-Eq	Programmed polarity
9	+V	Supply	Positive supply	+5V
10	GND	Common	Digital ground	
This connector provides the position-compare outputs for the eight encoder channels.				

J9 (JMACH1) Connector Description

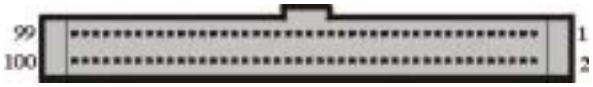
J9 JMACH1 Connector



Front View

Pin#	Symbol	Function	Description	Notes
1	+5V	Output / Input	+5V power	For external circuit or from external supply
2	+5V	Output / Input	+5V power	For external circuit or from external supply
3	GND	Common	Reference voltage	
4	GND	Common	Reference voltage	
5	CHA1+	Input	Encoder 1 positive A channel	Also pulse input
6	CHA1-	Input	Encoder 1 negative A channel	Also pulse input
7	CHB1+	Input	Encoder 1 positive B channel	Also direction input
8	CHB1-	Input	Encoder 1 negative B channel	Also direction input
9	CHC1+	Input	Encoder 1 positive C channel	Index channel
10	CHC1-	Input	Encoder 1 negative C channel	Index channel
11	CHU1	Input	Channel 1 U flag	Hall effect, fault code, or sub-count
12	CHV1	Input	Channel 1 V flag	Hall effect, fault code, or sub-count
13	CHW1	Input	Channel 1 W flag	Hall effect, fault code, or sub-count
14	CHT1	Input	Channel 1 T flag	Fault code, or sub-count
15	USER1	Input	General purpose user flag	Hardware capture flag, or sub-count
16	PLIM1	Input	Positive overtravel limit	Hardware capture flag
17	MLIM1	Input	Negative overtravel limit	Hardware capture flag
18	HOME1	Input	Home switch input	Hardware capture flag
19	ACCFLT1	Input	Accessory fault flag	For loss of ACC supply voltage
20	WD0/	Output	Watchdog output	Low is PMAC watchdog fault
21	SCLK12+	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
22	SCLK12-	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
23	ADC_CLK1+	Output	A/D converter clock	Programmable frequency

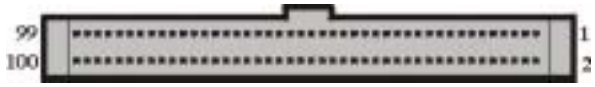
J9 JMACH1 Connector (Continued)



Front View

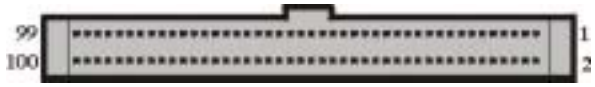
Pin#	Symbol	Function	Description	Notes
25	ADC_STB1+	Output	A/D converter strobe	Programmable sequence
26	ADC_STB1-	Output	A/D converter strobe	Programmable sequence
27	ADC_DAA1+	Input	Channel A ADC serial data	MSB first
28	ADC_DAA1-	Input	Channel A ADC serial data	MSB first
29	ADC_DAB1+	Input	Channel B ADC serial data	MSB first
30	ADC_DAB1-	Input	Channel B ADC serial data	MSB first
31	AENA1+	Output	Amplifier enable	High is enable
32	AENA1-	Output	Amplifier enable	Low is enable
33	FAULT1+	Input	Amplifier fault	Programmable polarity
34	FAULT1-	Input	Amplifier fault	Programmable polarity
35	PWMATOP1+ DAC_CLK1+	Output	Phase A Top CMD or DAC clock	Programmable function control
36	PWMATOP1- DAC_CLK1-	Output	Phase A Top CMD or DAC clock	Programmable function control
37	PWMABOT1+ DAC1A+	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
38	PWMABOT1- DAC1A-	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
39	PWMBTOP1+ DAC_STB1+	Output	Phase B Top CMD or DAC strobe	Programmable function control
40	PWMBTOP1- DAC_STB1-	Output	Phase B Top CMD or DAC strobe	Programmable function control
41	PWMBBOT1+ DAC1B+	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
42	PWMBBOT1- DAC1B-	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
43	PWMCTOP1+ DIR1+	Output	Phase B Top CMD or PFM direction	Programmable function control
44	PWMCTOP1- DIR1-	Output	Phase B Top CMD or PFM direction	Programmable function control
45	PWMCBOT1+ PULSE1+	Output	Phase B Bottom CMD or PFM pulse	Programmable function control
46	PWMCBOT1- PULSE1-	Output	Phase B Bottom CMD or PFM pulse	Programmable function control
47	GND	Common	Reference voltage	
48	GND	Common	Reference voltage	
49	+5V	Output / Input	+5V power	For external circuit or from external supply
50	+5V	Output / Input	+5V power	For external circuit or from external supply
51	+5V	Output / Input	+5V power	For external circuit or from external supply
52	+5V	Output / Input	+5V power	For external circuit or from external supply
53	GND	Common	Reference voltage	
54	GND	Common	Reference voltage	
55	CHA2+	Input	Encoder 2 positive A channel	Also pulse input

J9 JMACH1 Connector (Continued)

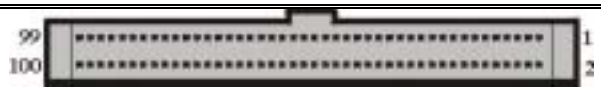


Front View

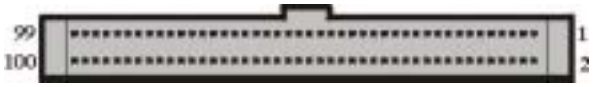
Pin#	Symbol	Function	Description	Notes
56	CHA2-	Input	Encoder 2 negative A channel	Also pulse input
57	CHB2+	Input	Encoder 2 positive B channel	Also direction input
58	CHB2-	Input	Encoder 2 negative B channel	Also direction input
59	CHC2+	Input	Encoder 2 positive C channel	Index channel
60	CHC2-	Input	Encoder 2 negative C channel	Index channel
61	CHU2	Input	Channel 2 U flag	Hall effect, fault code, or sub-count
62	CHV2	Input	Channel 2 V flag	Hall effect, fault code, or sub-count
63	CHW2	Input	Channel 2 W flag	Hall effect, fault code, or sub-count
64	CHT2	Input	Channel 2 T flag	Fault code, or sub-count
65	USER2	Input	General purpose user flag	Hardware capture flag, or sub-count
66	PLIM2	Input	Positive overtravel limit	Hardware capture flag
67	MLIM2	Input	Negative overtravel limit	Hardware capture flag
68	HOME2	Input	Home switch input	Hardware capture flag
69	ACCFLT2	Input	Accessory fault flag	For loss of ACC supply voltage
70	WD0/	Output	Watchdog output	Low is PMAC watchdog fault
71	SCLK12+	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
72	SCLK12-	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
73	ADC_CLK2+	Output	A/D converter clock	Programmable frequency
74	ADC_CLK2-	Output	A/D converter clock	Programmable frequency
75	ADC_STB2+	Output	A/D converter strobe	Programmable sequence
76	ADC_STB2-	Output	A/D converter strobe	Programmable sequence
77	ADC_DAA2+	Input	Channel A ADC serial data	MSB first
78	ADC_DAA2-	Input	Channel A ADC serial data	MSB first
79	ADC_DAB2+	Input	Channel B ADC serial data	MSB first
80	ADC_DAB2-	Input	Channel B ADC serial data	MSB first
81	AENA2+	Output	Amplifier enable	High is enable
82	AENA2-	Output	Amplifier enable	Low is enable
83	FAULT2+	Input	Amplifier fault	Programmable polarity
84	FAULT2-	Input	Amplifier fault	Programmable polarity
85	PWMATOP2+ DAC_CLK2+	Output	Phase A Top CMD or DAC clock	Programmable function control
86	PWMATOP2- DAC_CLK2-	Output	Phase A Top CMD or DAC clock	Programmable function control
87	PWMABOT2+ DAC2A+	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
88	PWMABOT2- DAC2A-	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
89	PWMBTOP2+ DAC_STB2+	Output	Phase B Top CMD or DAC strobe	Programmable function control

J9 JMACH1 Connector (Continued)			 Front View	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
90	PWMBTOP2- DAC_STB2-	Output	Phase B Top CMD or DAC strobe	Programmable function control
91	PWMBBOT2+ DAC2B+	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
92	PWMBBOT2- DAC2B-	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
93	PWMCTOP2+ DIR2+	Output	Phase B Top CMD or PFM direction	Programmable function control
94	PWMCTOP2- DIR2-	Output	Phase B Top CMD or PFM direction	Programmable function control
95	PWMCBOT2+ PULSE2+	Output	Phase B Bottom CMD or PFM pulse	Programmable function control
96	PWMCBOT2- PULSE2-	Output	Phase B Bottom CMD or PFM pulse	Programmable function control
97	GND	Common	Reference voltage	
98	GND	Common	Reference voltage	
99	+5V	Output / Input	+5V power	For external circuit or from external supply
100	+5V	Output / Input	+5V power	For external circuit or from external supply
The JMACH1 connector provides the interface pins for channels 1 and 2. Usually, it is connected to a breakout board, such as one of the Acc-8x family of boards, or an application-specific interface board.				

J10 (JMACH2) Connector Description

J10 JMACH2 Connector			 Front View	
Pin#	**Symbol**	**Function**	**Description**	**Notes**
1	+5V	Output / Input	+5V power	For external circuit or from external supply
2	+5V	Output / Input	+5V power	For external circuit or from external supply
3	GND	Common	Reference voltage	
4	GND	Common	Reference voltage	
5	CHA3+	Input	Encoder 3 positive A channel	Also pulse input
6	CHA3-	Input	Encoder 3 negative A channel	Also pulse input
7	CHB3+	Input	Encoder 3 positive B channel	Also direction input
8	CHB3-	Input	Encoder 3 negative B channel	Also direction input
9	CHC3+	Input	Encoder 3 positive C channel	Index channel
10	CHC3-	Input	Encoder 3 negative C channel	Index channel
11	CHU3	Input	Channel 3 U flag	Hall effect, fault code, or sub-count
12	CHV3	Input	Channel 3 V flag	Hall effect, fault code, or sub-count
13	CHW3	Input	Channel 3 W flag	Hall effect, fault code, or sub-count

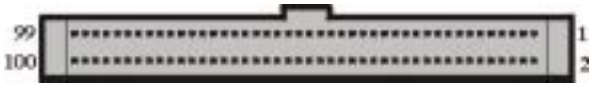
J10 JMACH2 Connector (Continued)



Front View

Pin#	Symbol	Function	Description	Notes
14	CHT3	Input	Channel 3 T flag	Fault code, or sub-count
15	USER3	Input	General purpose user flag	Hardware capture flag, or sub-count
16	PLIM3	Input	Positive overtravel limit	Hardware capture flag
17	MLIM3	Input	Negative overtravel limit	Hardware capture flag
18	HOME3	Input	Home switch input	Hardware capture flag
19	ACCFLT3	Input	Accessory fault flag	For loss of acc supply voltage
20	WD0/	Output	Watchdog output	Low is PMAC watchdog fault
21	SCLK34+	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
22	SCLK34-	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
23	ADC_CLK3+	Output	A/D converter clock	Programmable frequency
24	ADC_CLK3-	Output	A/D converter clock	Programmable frequency
25	ADC_STB3+	Output	A/D converter strobe	Programmable sequence
26	ADC_STB3-	Output	A/D converter strobe	Programmable sequence
27	ADC_DAA3+	Input	Channel A ADC serial data	MSB first
28	ADC_DAA3-	Input	Channel A ADC serial data	MSB first
29	ADC_DAB3+	Input	Channel B ADC serial data	MSB first
30	ADC_DAB3-	Input	Channel B ADC serial data	MSB first
31	AENA3+	Output	Amplifier enable	High is enable
32	AENA3-	Output	Amplifier enable	Low is enable
33	FAULT3+	Input	Amplifier fault	Programmable polarity
34	FAULT3-	Input	Amplifier fault	Programmable polarity
35	PWMATOP3+ DAC_CLK3+	Output	Phase A Top CMD or DAC clock	Programmable function control
36	PWMATOP3- DAC_CLK3-	Output	Phase A Top CMD or DAC clock	Programmable function control
37	PWMABOT3+ DAC3A+	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
38	PWMABOT3- DAC3A-	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
39	PWMBTOP3+ DAC_STB3+	Output	Phase B Top CMD or DAC strobe	Programmable function control
40	PWMBTOP3- DAC_STB3-	Output	Phase B Top CMD or DAC strobe	Programmable function control
41	PWMBBOT3+ DAC3B+	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
42	PWMBBOT3- DAC3B-	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
43	PWMCTOP3+ DIR3+	Output	Phase B Top CMD or PFM direction	Programmable function control
44	PWMCTOP3- DIR3-	Output	Phase B Top CMD or PFM direction	Programmable function control
45	PWMCBOT3+ PULSE3+	Output	Phase B Bottom CMD or PFM pulse	Programmable function control

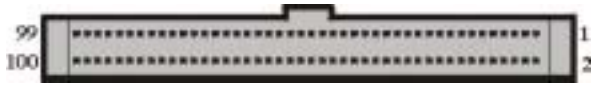
J10 JMACH2 Connector (Continued)



Front View

Pin#	Symbol	Function	Description	Notes
46	PWMCBOT3- PULSE3-	Output	Phase B Bottom CMD or PFM pulse	Programmable function control
47	GND	Common	Reference voltage	
48	GND	Common	Reference voltage	
49	+5V	Output / Input	+5V power	For external circuit or from external supply
50	+5V	Output / Input	+5V power	For external circuit or from external supply
51	+5V	Output / Input	+5V power	For external circuit or from external supply
52	+5V	Output / Input	+5V power	For external circuit or from external supply
53	GND	Common	Reference voltage	
54	GND	Common	Reference voltage	
55	CHA4+	Input	Encoder 4 positive A channel	Also pulse input
56	CHA4-	Input	Encoder 4 negative A channel	Also pulse input
57	CHB4+	Input	Encoder 4 positive B channel	Also direction input
58	CHB4-	Input	Encoder 4 negative B channel	Also direction input
59	CHC4+	Input	Encoder 4 positive C channel	Index channel
60	CHC4-	Input	Encoder 4 negative C channel	Index channel
61	CHU4	Input	Channel 4 U flag	Hall effect, fault code, or sub-count
62	CHV4	Input	Channel 4 V flag	Hall effect, fault code, or sub-count
63	CHW4	Input	Channel 4 W flag	Hall effect, fault code, or sub-count
64	CHT4	Input	Channel 4 T flag	Fault code, or sub-count
65	USER4	Input	General purpose user flag	Hardware capture flag, or sub-count
66	PLIM4	Input	Positive overtravel limit	Hardware capture flag
67	MLIM4	Input	Negative overtravel limit	Hardware capture flag
68	HOME4	Input	Home switch input	Hardware capture flag
69	ACCFLT4	Input	Accessory fault flag	For loss of ACC supply voltage
70	WD0/	Output	Watchdog output	Low is PMAC watchdog fault
71	SCLK34+	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
72	SCLK34-	Input / Output	Encoder sample clock	Direction controlled by PMAC2 jumper
73	ADC_CLK4+	Output	A/D converter clock	Programmable frequency
74	ADC_CLK4-	Output	A/D converter clock	Programmable frequency
75	ADC_STB4+	Output	A/D converter strobe	Programmable sequence
76	ADC_STB4-	Output	A/D converter strobe	Programmable sequence
77	ADC_DAA4+	Input	Channel A ADC serial data	MSB first
78	ADC_DAA4-	Input	Channel A ADC serial data	MSB first
79	ADC_DAB4+	Input	Channel B ADC serial data	MSB first
80	ADC_DAB4-	Input	Channel B ADC serial data	MSB first

J10 JMACH2 Connector (Continued)



Front View

Pin#	Symbol	Function	Description	Notes
81	AENA4+	Output	Amplifier enable	High is enable
82	AENA4-	Output	Amplifier enable	Low is enable
83	FAULT4+	Input	Amplifier fault	Programmable polarity
84	FAULT4-	Input	Amplifier fault	Programmable polarity
85	PWMATOP4+ DAC_CLK4+	Output	Phase A Top CMD or DAC clock	Programmable function control
86	PWMATOP4- DAC_CLK4-	Output	Phase A Top CMD or DAC clock	Programmable function control
87	PWMABOT4+ DAC4A+	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
88	PWMABOT4- DAC4A-	Output	Phase A Bottom CMD or DAC A serial data	Programmable function control
89	PWMBTOP4+ DAC_STB4+	Output	Phase B Top CMD or DAC strobe	Programmable function control
90	PWMBTOP4- DAC_STB4-	Output	Phase B Top CMD or DAC strobe	Programmable function control
91	PWMBBOT4+ DAC4B+	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
92	PWMBBOT4- DAC4B-	Output	Phase B Bottom CMD or DAC B serial data	Programmable function control
93	PWMCTOP4+ DIR4+	Output	Phase B Top CMD or PFM direction	Programmable function control
94	PWMCTOP4- DIR4-	Output	Phase B Top CMD or PFM direction	Programmable function control
95	PWMCBOT4+ PULSE4+	Output	Phase B Bottom CMD or PFM pulse	Programmable function control
96	PWMCBOT4- PULSE4-	Output	Phase B Bottom CMD or PFM pulse	Programmable function control
97	GND	Common	Reference voltage	
98	GND	Common	Reference voltage	
99	+5V	Output / Input	+5V power	For external circuit or from external supply
100	+5V	Output / Input	+5V power	For external circuit or from external supply

The JMACH2 connector provides the interface pins for channels 3 and 4. Usually, it is connected to a breakout board, such as one of the Acc-8x family of boards, or an application-specific interface board.

TB1 (2/4-Pin Terminal Block)

This terminal block can be used to provide the input for the power supply for the circuits on the PMAC2 board when it is not in a bus configuration. When the PMAC2 Lite is in a bus configuration, these supplies come through the bus connector from the bus power supply automatically; in this case, this terminal block should not be used.

Pin#	Symbol	Function	Description	Notes
1	GND	Common	Reference voltage	
2	+5V	Input	Positive supply voltage	Supplies all PMAC digital circuits
3	+12V	Input	Positive supply voltage	+12v to +15v; not required on-board; used on J1 to supply analog inputs
4	-12V	Input	Negative supply voltage	-12v to -15v; required for opt-12 ADCs; used on J1 to supply analog inputs
Note: Unless Option 12 (Analog-to-Digital Converters) is included on the board, only pins 1 and 2 will be provided on this terminal block.				

TB2 (3-Pin Terminal Block)

This terminal block provides the output for PMAC2's watchdog timer relay, both normally open and normally closed contacts.

Pin#	Symbol	Function	Description	Notes
1	WD_NC	Output	Watchdog relay out	Normally closed
2	COM	Input	Watchdog return	+V or 0V
3	WD_NO	Output	Watchdog relay out	Normally open
Note: The normally closed relay contact is open while PMAC2 Lite is operating properly — it has power and the watchdog timer is not tripped. This contact is closed when the PMAC2 Lite is not operating properly (either the PMAC has lost power or the watchdog timer has tripped). The normally open relay contact is closed while PMAC2 is operating properly, and open when PMAC2 is not operating properly.				